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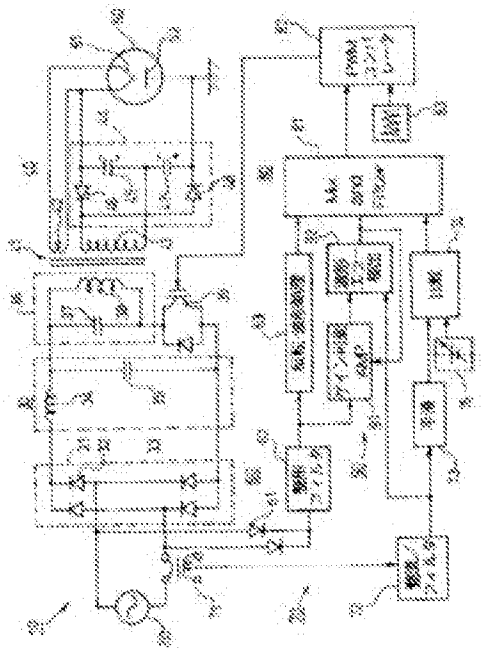
(54) POWER CONTROL METHOD AND DEVICE FOR HIGH-FREQUENCY DIELECTRIC HEATING

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a power control method for high-frequency dielectric heating free from an influence from the variation, if any, of kinds of magnetrons or their characteristics or from the temperature variation of an anode of the magnetron.
SOLUTION: An input current of an inverter circuit rectifying a voltage of an alternate current power source (20) and inverting it to an alternate current of a given frequency is detected (71), and the detected current is rectified to find (72) an input current waveform. On the other hand, the alternate current power source voltage is rectified (61), a reference waveform is found (91) by waveform shaping, the difference of the inputted current waveform and the reference waveform is found (92), and difference information and a current control output are mixed by a mixing circuit (81) to convert it into a drive output of a switching transistor (39) of the inverter circuit.



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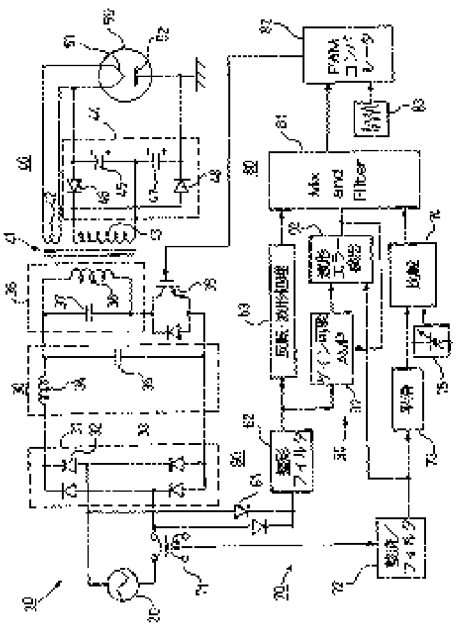
(54)【発明の名称】高周波誘電加熱用電力制御方法およびその装置

(57)【要約】
【課題】マグネトロンの種類やその特性にバラツキがあっても、またマグネトロンのアノードの温度変動があっても、それらの影響を受けない高周波誘電加熱用電力制御方法を提供する。
【解決手段】交流電源（２０）の電圧を整流して所定周波数の交流に変換するインバータ回路の入力電流を検知し（７１）、該検出電流を整流して入力電流波形を求め（７２）、一方、前記交流電源電圧を整流し（６１）、波形整形して基準波形を求め（９１）、前記入力電流波形と前記基準波形との差を求め（９２）、該差情報と電流制御出力とをミックス回路（８１）でミックスして前記インバータ回路のスイッチングトランジスタ（３９）の駆動出力に変換する。
【選択図】　図１



DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]
This invention relates to the high-frequency dielectric heating using a magnetron like a microwave oven.
It is especially related with the variation in the characteristic of a magnetron, a kind, and the high-frequency dielectric heating that is not influenced by it at differences, such as temperature of the anode of a magnetron.

[0002]
[Description of the Prior Art]
The conventional publicly known high frequency heating device is adjusting the electric power supplied to a magnetron with the output pulse width of the inverter control circuit. When the output voltage of the signal superposing means became high, the output pulse width of said inverter control circuit became large, and the electric power supplied to a magnetron had become the composition which becomes large. It was possible to have changed the output voltage of a signal superposing means and to have changed the heating output of a magnetron continuously by this composition.
Since the heater served as the cathode of a magnetron, and the transformer which supplies electric power to a magnetron supplied electric power also to the heater, the electric power supplied to a heater according to change of the electric power supplied to a magnetron was also changing. For this reason, when it was going to put heater temperature into the proper range, only the variation width of few heating outputs could be taken, but there was a problem it becomes impossible to change a heating output continuously.
[0003]
There is a control system (JP,H7-176375,A) which these people developed previously and for which they applied as a high frequency heating device which solves this. Drawing 12 is a figure explaining the high frequency heating device which carries out this control system. The transformer 703 which supplies electric power to the heater 715 of said magnetron 701 at the same time this heating control system supplies high tension power to the high voltage rectification circuit 702 which supplies secondary volume electric power to the magnetron 701 and the magnetron 701 in drawing 12, The inverter circuit 705 which rectifies AC power supply 704, changes it into exchange of predetermined frequency, and is supplied to the transformer 703, The power detection means 706 which detects the input power or the output power of the inverter circuit 705, The output set part 707 which outputs the output setpoint signal corresponding to heating output setting out for which it asks, The power conditioning part 708 which controls the direct current level of a power conditioning signal to become a heating output which compares and asks for the output and said output setpoint signal of the power detection means 706, A dispatch detection means 719 by which the dispatch detection signal which is an output when the output of the power detection means 706 is set to 718 or more output levels of a reference voltage generation means serves as HI from LO, The comparison voltage generation circuit 716 which generates the voltage corresponding to said output setpoint signal, The waveform-shaping signal which compared the output setpoint signal by the level conversion circuit 720, and the waveform shaping circuit 721 which operates orthopedically the output of the rectification circuit 710 which rectifies AC power voltage 704 based on said waveform-shaping signal and said dispatch detection signal, The comparison circuit 711 which outputs comparison reference voltage when small as compared with the output of said comparison voltage generation circuit, and carries out reversal amplification of the output signal of the waveform shaping circuit 721 when large, The signal superposing means

712 which superimposes the fluctuating signal of the output of the comparison circuit 711 on said power conditioning signal, and outputs a pulse width control signal, It has composition provided with the oscillating circuit 713 and the inverter control circuit 714 which carries out Pulse Density Modulation of the output of the oscillating circuit 713 with said pulse width control signal, and drives said inverter circuit 5 with this abnormal-conditions output.
[0004]
The above-mentioned high frequency heating device is adjusting the electric power supplied to the magnetron 701 with the width of the output pulse of the inverter control circuit 714. If the output voltage of the signal superposing means 712 becomes high, the output pulse width of said inverter control circuit 714 will become large, and the electric power supplied to the magnetron 701 becomes large. It is possible by changing the output voltage of the signal superposing means 12 continuously in this equipment to change the heating output of the magnetron 701 continuously.
According to this composition, according to output setting out, it is orthopedically operated by the waveform shaping circuit 721 which inputs the rectified voltage of AC power supply 704, and is outputted to the comparison circuit 711. Reversal amplification is carried out by the comparison circuit 711 which has the comparison voltage generation circuit 716 which generates the reference signal of the level corresponding to a heating output setpoint signal for the output of this waveform shaping circuit 721 as reference voltage, Said pulse width control signal which is an output signal of the signal superposing means 712 by superimposing the output of the power conditioning part 708 on this reversal amplified signal, Since the level near the amplitude maximum of AC power supply 704 becomes lower as compared with the time of high power at the time of low-power output and heating output setting out becomes more expensive [the level of said magnetron non oscillation portion], the dispatch period around a power supply round term of a magnetron becomes long. The electric power supplied to a heater by this becomes large. Furthermore, the input current waveform of an inverter is convex near an envelope peak, and turns into a waveform near the rectification waveform of a sine wave at the time of high power, and harmonic current is suppressed.
Thus, by the waveform shaping circuit 721, many a pulse width control signal so that the heater current may be at the time of low-power output, By controlling so that power supply current harmonics become small at the time of high power, power supply current harmonics can be suppressed low, moreover change of the heater current can be made small, and a reliable high frequency heating device can be realized.
[0005]
[Problem to be solved by the invention]
However, in this control to the ON/OFF drive pulse of a switching transistor. Since waveform shaping by a "prospective control system" is carried out so that Pulse Density Modulation of the commercial power waveform may be carried out using the modulated wave form processed and operated orthopedically and an input current waveform may approach a sine wave, It became clear to the variation in the characteristic of a magnetron, a kind, and it the ebm (voltage between anode cathodes) change by the temperature of the anode of a magnetron or the load in a microwave oven and that waveform shaping cannot be further followed even to line voltage variation.
[0006]
Here, the variation and the kind of the characteristic of magnetron used as the motivation of this invention are explained briefly. As drawing 13 showed, for nonlinear load, the VAK(anode cathode voltage)-Ib characteristic of the magnetron modulated ON width according to the phase of commercial power, brought the input current waveform close to a sine wave, and carried out improvement in a power-factor.
And this nonlinear characteristic of a magnetron changes with kinds of magnetron, and is changed also with magnetron temperature and the load in a microwave oven.
[0007]
Drawing 13 is an anode cathode impressed-electromotive-force-anode current

characteristic figure of a magnetron, (c) is a figure showing the difference arising from the temperature of a magnetron, respectively, and in common with (a) - (c), (b) makes a mistake in (a's) making a mistake in being based on the kind of magnetron, and being based on the right and wrong of matching of electric supply of a magnetron, and a horizontal axis is [a vertical axis is the voltage between anode cathodes, and] anode current.
Then, if it sees about (a), A, B, and C are the characteristic figures of three kinds of magnetrons, and in the case of the magnetron A, only one or less-IA slight current will flow through current until VAK is set to VAK1 (=ebm). However, if VAK exceeds VAK1, the current IA will begin to increase rapidly. In this field, IA will change a lot by the slight difference in VAK. Next, in the case of the magnetron B, VAK2 (= ebm) is lower than VAK1, and, in the case of the magnetron C, VAK3 (= ebm) is still lower than VAK2 further. Thus, in the modulated wave type which ebm doubled with the low magnetron, since this nonlinear characteristic of a magnetron changes with kinds A, B, and C of magnetron, when ebm uses a high magnetron, the input current waveform has been distorted. With equipment, these problems were not able to be coped with conventionally. Then, it has been problem to make the high-frequency-dielectric-heating circuit which does not receive those kinds of influences.
[0008]
If it similarly sees about (b), the characteristic figure of three kinds of magnetrons shows the good of impedance matching of the heat chamber seen from the magnetron, and wrong. When impedance matching is good, it becomes small as VAK1 (= ebm) worsens by the maximum in the following. Thus, it has been problem that this nonlinear characteristic of a magnetron makes the good of impedance matching and the high-frequency-dielectric-heating circuit which does not receive those kinds of influences since it differs greatly even when it is poor.
[0009]
If it similarly sees about (c), the characteristic figure of three kinds of magnetrons shows the height of the temperature of a magnetron. When temperature is low, in ebm, VAK1 (= ebm) becomes low at the maximum as temperature becomes high gradually below. Therefore, when the temperature of the magnetron was doubled with the lower one, and the temperature of a magnetron became high, that an input voltage waveform is distorted broke out.
Thus, it has been problem that it makes the high-frequency-dielectric-heating circuit which does not receive those kinds of influences since the nonlinear characteristic of a magnetron differs also in the difference in the temperature of a magnetron greatly.
And compensation of these change was omitted conventionally in the circuit and the aforementioned circuit.
[0010]
Then, even if the problem of this invention has variation in the kind of magnetron, or its characteristic, It is in providing the ebm (voltage between anode cathodes) change by the temperature of the anode of a magnetron, or the load in a microwave oven, the high-frequency-dielectric-heating method of not receiving those influences even if line voltage variation occurs further, and equipment.
[0011]
[Means for solving problem]
in order to solve an aforementioned problem -- the power controls for high-frequency dielectric heating according to claim 1 -- an invention of process, Detect the input current of the inverter circuit which rectifies and carries out high frequency switching of the AC power voltage, and is changed into high-frequency power, and it asks for an input current waveform, On the other hand, from said AC-power-voltage waveform, it asks for a reference waveform, the difference of said input current waveform and said reference waveform is searched for, this difference information and a power-controls output are mixed, and it changes into the driving signal of the switching transistor of said inverter circuit.

the power controls for high-frequency dielectric heating according to claim 2 -- an invention of process, The input current of the inverter circuit which rectifies and carries out high frequency switching of the AC power voltage, and is changed into high-frequency power is detected, Rectify this detection current, and ask for an input current waveform and, on the other hand, said AC power voltage is rectified, It shapes in waveform, and asks for a reference waveform, the difference of said input current waveform and said reference waveform is searched for, this difference information and a current control output are mixed in a mix circuit, and it changes into the driving output of the switching transistor of said inverter circuit.

In the power-controls method for high-frequency dielectric heating according to claim 1 or 2, said reference waveform obtains the invention according to claim 3 by changing a commercial source voltage waveform through gain variable amplifier.

The invention according to claim 4 makes said reference waveform and difference information with said input current waveform the control input signal of said gain variable amplifier in the power-controls method for high-frequency dielectric heating according to claim 3.

The invention according to claim 5 has the composition that said mix circuit omits the high-frequency component of said current control output, in the power-controls method for high-frequency dielectric heating of Claims 1-4 given in any 1 clause.

In the power-controls method for high-frequency dielectric heating of Claims 1-5 given in any 1 clause, the invention according to claim 6 makes the signal which reversed the waveform which rectified and shaped said AC power voltage in waveform, and carried out waveform processing an auxiliary modulating signal, and inputs it into said mix circuit.

In the power-controls method for high-frequency dielectric heating of Claims 1-6 given in any 1 clause, the invention according to claim 7 provides the limiting circuit which restricts a waveform in the plus direction and the minus direction of said difference information, and inputs it into said mix circuit.

The invention according to claim 8 provides a difference in the current increase and rising characteristics at the current error signal which is a difference of the value and current reference signal which carried out smoothness of said input current waveform in the power-controls method for high-frequency dielectric heating of Claims 1-7 given in any 1 clause.

The invention according to claim 9 adds the limiter function which controls the collector voltage of said switching transistor to a specified value to said current control output in the power-controls method for high-frequency dielectric heating of Claims 1-8 given in any 1 clause.

In the power-controls method for high-frequency dielectric heating of Claims 1-9 given in any 1 clause, the invention according to claim 10 omits the high-frequency component of said difference information, and is taken as the control input signal of gain variable amplifier.

The reference signal conversion method which brings said reference waveform signal close to zero is established at the time of the phase to which the invention according to claim 11 becomes low [said AC power voltage] in the power-controls method for high-frequency dielectric heating of Claims 1-10 given in any 1 clause.

The invention according to claim 12 forms the filter which attenuates the harmonic-distortion ingredient of commercial power frequency in the plastic surgery filter circuit which rectifies said AC power voltage in the power-controls method for high-frequency dielectric heating of Claims 1-11 given in any 1 clause.

The invention according to claim 13 advances the phase of said reference waveform beforehand in consideration of the time delay of a control system in the power-controls method for high-frequency dielectric heating of Claims 1-12 given in any 1 clause.

Invention of the power control unit for high-frequency dielectric heating according to claim 14, A current detection means to detect the input current of the inverter circuit which rectifies and carries out high frequency switching of the AC power voltage, and is

changed into high-frequency power, The 1st conversion-of-waveform means that changes the output of this current detection means into an input current waveform signal, The 2nd conversion-of-waveform means that changes said AC-power-voltage waveform into a reference waveform signal, The waveform error detection circuit which outputs a waveform error signal in quest of the difference of the input current waveform signal from said 1st conversion-of-waveform means, and the reference waveform signal from said 2nd conversion-of-waveform means, It had the driving signal conversion method which mixes this waveform error signal and a power-controls output, and is changed into the driving signal of the switching transistor of said inverter circuit.
Invention of the power control unit for high-frequency dielectric heating according to claim 15, A current detection means to detect the input current of the inverter circuit which rectifies and carries out high frequency switching of the AC power voltage, and is changed into high-frequency power, The 1st rectification circuit that rectifies the current signal from this current detection means, and the 2nd rectification circuit that rectifies said AC power voltage, The shaping circuit which shapes the output of this 2nd rectification circuit in waveform, and the gain variable amplifier circuit which carries out gain variable [of the output signal from said shaping circuit], and outputs a reference waveform signal, It had the waveform error detection circuit which outputs a waveform error signal according to the difference of the input current waveform signal from said 1st rectification circuit, and the reference waveform signal from said gain variable amplifier circuit.
[0012]
[Mode for carrying out the invention]
Hereafter, this invention is explained using Drawings.
Drawing 1 is a figure explaining the high frequency heating device concerning this invention.
In drawing 1, it is rectified in the diode bridge type rectification circuit 31 which comprises the four diodes 32, and the volts alternating current of AC power supply 20 is changed into direct current voltage through the smoothing circuit 30 which comprises the inductor 34 and the capacitor 35. Then, it is changed into high-frequency ac by the capacitor 37, the resonant circuit 36 which comprises the primary winding 38 of the transformer 41, and the inverter circuit which comprises the switching transistor 39, and high frequency high voltage is induced by the secondary side coil 43 via the transformer 41.
[0013]
High tension is impressed between the anode 52 of the magnetron 50, and the cathode 51 via the voltage doubler rectifier circuit where the high frequency high voltage induced by the secondary side coil 43 comprises the capacitor 45, the diode 46, the capacitor 47, and the diode 48. There is the 3rd winding 42 in the transformer 41, and this heats the heater (cathode) 51 of the magnetron 50. The above is an inverter main circuit.
[0014]
Next, the control circuit which controls the switching transistor 39 of an inverter is explained. In a ready sink and the smoothing circuit 73, detect the input current of an inverter circuit by the current detection means 71, such as CT, carry out smoothness of the current signal from the current detection means 71, and in the rectification circuit 72 First, this, The signal from the output set part 75 which outputs the output setpoint signal corresponding to heating output setting out of another side is compared in the comparison circuit 74. Since the comparison circuit 74 performs comparison for controlling the size of electric power, even if the anode current signal of the magnetron 50 or the collector current signal of the switching transistor 39 is an input signal instead of said input current signal, its this invention is effective.
On the other hand, AC power supply 20 is shaped in waveform for the diode 61 in a ready sink and the shaping circuit 62. Then, the signal from the shaping circuit 62 is reversed in reversal and the waveform processing circuit 63, and waveform processing is carried out.
[0015]

Change the output signal from the shaping circuit 62 in the below-mentioned gain variable amplifier circuit 91 provided by this invention, and it outputs a reference current waveform signal, It outputs as a waveform error signal by the waveform error detection circuit 92 in which the difference of the input current waveform signal from the rectification circuit 72 and the reference waveform signal from this gain variable amplifier circuit 91 was similarly provided by this invention.
[0016]
The waveform error signal from this waveform error detection circuit 92, and the current error signal from the comparison circuit 74 The mix and filter circuit 81. (it is hereafter called a "mix circuit".) -- it mixing, and it filtering, an ON voltage signal being outputted, and the saw wave and the PWM comparator 82 from the saw wave generation circuit 83 comparing, and, Pulse Density Modulation is carried out and on-off control of the switching transistor 39 of an inverter circuit is carried out.
[0017]
Drawing 2 shows one example of the mix circuit 81. An auxiliary modulating signal adds a waveform error signal to those with three, and the terminal 811, it is added to the terminal 812, a current error signal is added to the terminal 813, and the input terminal of the mix circuit 81 is mixed in an internal circuit as shown in a figure.
Although 810 is a high frequency cut-off filter and being mentioned later, it has the function to remove the high frequency component of the current error signal which does not need a high frequency component. It is because a changed part of a waveform error signal will stop coming out finely if a high frequency component exists when mixed with a waveform error signal.
[0018]
(Embodiment of the invention 1)
The embodiment of the invention 1 creates automatically the waveform standard which followed the size of the input current by the gain variable amplifier circuit 91 as mentioned above, and This waveform standard, It mixes with the output of input current control of the waveform error information acquired by comparing the input current waveform obtained from the current detection means 71 in the waveform error detection circuit 92, and acquiring waveform error information, It is used for the on-off driving signal of the switching transistor 39 of an inverter circuit at conversion.
Drawing 3 is a figure explaining the waveform acquired by the embodiment of the invention 1, and (a) When an input current is large, (b) is when an input current is small, and (1) and (2) show the input-side signal (I is a reference current waveform and RO is an input current waveform) and output side signal (waveform error) of the waveform error detection circuit 92, respectively. Since a reference waveform follows an input current and changes the size in a figure, When an input current is large, when an input current is small, as shown in (2), in (b), only the waveform error appears [(a)] in the output side signal (waveform error) of the waveform error detection circuit 92, The dynamic range of the waveform error detection circuit 92 which creates a waveform error signal will always be kept large, and the characteristic becomes good.
[0019]
Thus, since the control loop operates so that an input current waveform may agree on the waveform standard which followed the size of the input current, Even if the kind of magnetron and its characteristic have variation, the ebm (voltage between anode cathodes) change by the temperature of the anode of a magnetron or the load in a microwave oven and the input current waveform plastic surgery which does not receive those influences even if line voltage variation occurs further can be made.
[0020]
(Embodiment of the invention 2)
He is trying to change the embodiment of the invention 2 into a reference waveform through the gain variable amplifier circuit 91 as mentioned above using a commercial source voltage waveform, and a power-factor serves as best by this. Namely, since it rectifies from commercial source voltage and a reference current signal wave form is

made, if commercial source voltage is close to a sine wave, a reference current signal wave form will also approach a sine wave, and, generally waveform distortion (waveform distortion that the peak part of a sine wave is crushed especially) will follow on commercial source voltage, but. In that case, since a reference current signal wave form is distorted similarly, an input current waveform will approach this and a reference current signal wave form is no longer influenced by power supply environment in preparation for both cases in the waveform after all, a power-factor becomes good. On the other hand, although the system which makes reference voltage with a microcomputer etc. conventionally is generally used, now, there is a big fault that it cannot respond to distortion of power supply voltage.

[0021]

(Embodiment of the invention 3)

Embodiment 3 feeds back said difference information to the gain variable amplifier circuit 91. as mentioned above, the reference waveform being able to change a commercial source voltage waveform, and it through the gain variable amplifier circuit 91, By feeding back further the difference information of this reference waveform and a current wave form to the gain variable amplifier circuit 91, and considering it as the amplifier control input signal of the gain variable amplifier circuit 91, Since the reference waveform can follow the size automatically in a current wave form, only a waveform error will appear in difference information, the dynamic range of the waveform error detection circuit 92 will be kept large, and the characteristic becomes good.

[0022]

(Embodiment of the invention 4)

The embodiment of the invention 4 is considering said mix circuit 81 as the composition which omits the high-frequency component of a current control output. Drawing 4 is a circuit which shows one of them. 810 is a high frequency component cut-off filter, and is inserting this high frequency component cut-off filter 810 in the terminal which takes in the current error signal from the comparator 74 among three input terminals of the mix circuit 81. The high frequency component cut-off filter 810 comprises a pi type filter which sandwiches the capacitors 815 and 816 from both sides right in the middle in the resistance 814 like a graphic display as one example.

By doing in this way, the high frequency component of the current error signal from the comparator 74 is removed, the noise of a current error signal ceases to carry out an adverse effect to waveform shaping, and a waveform becomes good.

[0023]

(Embodiment of the invention 5)

The embodiment of the invention 5 makes the output signal of said reversal and waveform processing circuit 63 an auxiliary modulating signal, and inputs it into the mix circuit 81. Namely, when not performing this, the dynamic range of the waveform error detection circuit 92 tended to be insufficient, but. Since the waveform error detection circuit 92 can perform fine waveform shaping, its accuracy improves, because are used as an auxiliary modulating signal, and it comes out of a modulating signal from reversal and the waveform processing circuit 63 and is made to perform rough abnormal conditions.

[0024]

(Embodiment of the invention 6)

The embodiment of the invention 6 provides the limiting circuit which carries out restriction of a plus direction and the minus direction to the difference information of said waveform error detection circuit 92, and he is trying to input it into the mix circuit 81. Drawing 5 is a figure explaining this embodiment, and, in a block diagram and (b), (a of a characteristic figure and (c)) is a wave form chart. In a figure (a), 921 by the limiting functions 921 provided by this embodiment into the waveform error detection circuit 92. If the reference waveform from the gain variable amplifier circuit 91 and the input current waveform from the rectification circuit 72 start the input of the waveform error detection circuit 92, a waveform error will be outputted to the mix circuit 81 through these limiting

functions 921.
[0025]
As for a figure (b), a waveform error value and the horizontal axis of a vertical axis are input current waveforms. A reference waveform is added to I0 of a horizontal axis. In the error detection characteristic, as shown in a figure, the limit straight lines L1 and L2 which limit a waveform error focusing on I0 on the line segment L0 of negative inclination and the predetermined level on which it is provided by this embodiment before and behind that continue.
[0026]
A figure (c) is a wave form chart and (1) is a waveform of the wave form chart added to a horizontal axis, and the waveform error signal to which (2) appears in a vertical axis. In (1), I is a reference waveform and RO is an input current waveform. Suppose that NI is disturbance. If reference waveform I is added to the horizontal axis I0 of a figure (b), when larger than this and input current waveform RO is small on the right-hand side of a figure focusing on this, it will sway on the left-hand side of a figure, and it will extend upwards vertically from the deflection position, and an intersection with the error detection ultimate lines L0 will serve as a waveform error value. Then, if input current waveform RO is too large, it will come to intersect the error detection ultimate lines L1, and a limit will start a waveform error. Also when input current waveform RO is too small, a limit starts a waveform error by similarly intersecting the error detection ultimate lines L2.
Therefore, waveform restriction of disturbance NI which invaded into input current waveform RO will be carried out by limiting functions, and the influence on a waveform error will be reduced.
Since a case so that an error signal may exceed a limit value is a problem when it turns out that it is what most depends on disturbance experientially, therefore this comes into a control system, the influence of disturbance is mitigable by this embodiment.
Since operation can be prevented also from a circuit being saturated and becoming unstable and a gain when there are still few errors can be enlarged, an input current waveform will follow a reference waveform more, and the subeffect that a power-factor improves is also acquired.
[0027]
(Embodiment of the invention 7)
The embodiment of the invention 7 is a thing as a current error signal only provides a difference in a current increase and rising characteristics. There are the technique of providing a difference in (1) inclination and the technique of providing a difference in (2) limit values in how to make the difference between a current increase and rising characteristics.
Drawing 6 is a figure explaining the technique of providing a difference in the current increase and rising characteristics concerning this embodiment, and, as for a block diagram and (b), the 1st characteristic figure and (c) of (a) are the 2nd characteristic figure.
In a figure (a), 741 in the increase and rising-characteristics difference processing circuit provided by this embodiment into the comparison circuit 74. If the input current signal from the smoothing circuit 73 and the reference signal from the output set part 75 go into the input side of the comparison circuit 74, a current error will be outputted to the mix circuit 81 through this increase and rising-characteristics difference processing circuit 741.
[0028]
In a figure (b), a vertical axis is a current error value and a horizontal axis is an input current signal. A reference signal is added to I0 of a horizontal axis. And as shown in a figure with this embodiment, when the error detection characteristic makes alpha the inclination of a left-hand side (side in which an input current is smaller than a reference signal) line segment with beta a center [the reference signal I0] for the inclination of the right-hand side (side with a larger input current than a reference signal) line segment L1,

Alpha>beta
When it carries out and a difference is set to e1, it is the feature to have applied the limit like the characteristic L3 and the characteristic L4 (it was alpha=beta conventionally.).
[0029]
As opposed to a big error signal being obtained by alpha, if it centers on the reference signal I0 and a bigger input current signal enters by this, and controlling early, When it centers on the reference signal I0 and a smaller input current signal enters, a small error signal will be obtained by beta, and it will control slowly. Thus, hunching (vibration) was made hard to produce by establishing a difference among both.
As mentioned above, the evil in which hunching by corresponding quickly conversely occurs is lessened, without according to this embodiment, corresponding quickly, since it is not dangerous when it controls quickly and the input current is less than the standard, since it is dangerous when an input current exceeds from a standard.
[0030]
(Modification of the embodiment of the invention 7)
A figure (c) is a figure explaining the technique of providing a difference in the limit value which is the 2nd characteristic figure. In a figure (c), a vertical axis is a current error value and a horizontal axis is an input current signal. A reference signal is added to I0 of a horizontal axis. And when the error detection characteristic sets a right-hand side (side with a larger input current than a reference signal) current error limit value to e1 with the line segment L1 of the fixed inclination alpha a center [the reference signal I0] as shown in a figure, and setting to e2 a left-hand side (side in which an input current is smaller than a reference signal) current error limit value by this embodiment,
e2<e1
Carrying out is the feature (it was e1=e2 conventionally.).
Since the current error signal will have set up e1 greatly if it centers on the reference signal I0 and a bigger input current signal enters by this, When a big signal is acquired, it centers on the reference signal I0 to being controlled quickly and a smaller input current signal enters, without being restricted, a current error signal will be restricted to e2, and will be controlled slowly. Thus, it becomes difficult to produce hunching (vibration) by establishing a difference among both.
As mentioned above, the evil in which hunching by corresponding quickly conversely occurs is lessened, without corresponding quickly, since it is not dangerous when it controls also by this technique quickly and the input current is less than the standard with it, since it is dangerous when an input current exceeds from a standard.
[0031]
(Embodiment of the invention 8)
The embodiment of the invention 8 is considering Vc limiter function which controls the collector voltage Vc of a switching transistor to a specified value as the composition added to a current control output.
Drawing 7 is a figure explaining the composition which adds Vc limiter function concerning the embodiment of the invention 8 to a current control output, (a) is a block diagram and (b) is an example of a concrete circuit. In drawing 7 (a), 74 is a comparison circuit of drawing 1, the input current signal from the smoothing circuit 73 (drawing 1) is inputted into the input terminal of one of these, the current reference signal from the output set part 75 is inputted into the input terminal of another side, and the difference of an input current signal and a current reference signal is outputted as a current error from an output terminal. a dotted line shows to the circuit shown in such drawing 1 caudad further by the embodiment of the invention 8 at drawing 7 -- a functional addition is carried out.
[0032]
In a figure (a), 740 by another comparator side provided by Embodiment 8. The collector voltage signal Vc of a switching transistor is inputted into the one input terminal 742 of the comparator 745, The impressed electromotive force at the time of the non oscillation of a magnetron is inputted into other input terminals 743 as the voltage reference signal

V2, From the comparator 745, the difference of the voltage signal Vc of the input terminal 742 and the voltage reference signal of the input terminal 743 is outputted to the output terminal 744, is added with the output of the above-mentioned comparison circuit 74, and let it be an error signal.
[0033]
A figure (b) is an example of a concrete circuit of a comparator. The comparator 74 is constituted from the two transistors T1 and T2, and the comparator 740 by this embodiment consists of two transistor T3 and T4. When each signal of a reference current, an input current, Vc, and a voltage standard is added to the base of each transistors T1-T4 and an input current exceeds a reference current at it, respectively, and when Vc exceeds a voltage standard, an output is produced to the both ends of the resistance R5, respectively, and this serves as a current error signal. When both the comparators operate, a synthetic output is produced to the both ends of the resistance R5, and this serves as a current error signal.
[0034]
The characteristic equivalent to different high resistance is indicated to be the characteristic shown in drawing 13 until the cathode of a magnetron can warm enough and the oscillation of it is attained. Therefore, the period which is operating the switching transistor 39 in order to send current through a filament from the 3rd winding 42 of a transformer (drawing 1) until an oscillation becomes possible (it is described as the time of a non oscillation below), The voltage impressed to the primary winding 38 of the transformer 41 was restricted, and excess voltage is prevented from being impressed to a magnetron.
Will make voltage V2 into a voltage reference signal at the time of the non oscillation of a magnetron, and Vc limiter function which controls the collector voltage Vc of the switching transistor 39 to a specified value by comparing with the collector voltage signal Vc of the switching transistor 39 will be added to a current control output, It becomes the simplification of a circuit. Since this voltage reference signal is changed to the voltage V1 higher than the voltage V2 at the time of the oscillation of a magnetron, it is supposed substantially that it is invalid.
[0035]
(Embodiment of the invention 9)
The embodiment of the invention 9 omits the high-frequency component of difference information, and is taken as the control input signal of gain variable amplifier. Thereby, stability becomes good.
Drawing 8 shows the embodiment of the invention 9, (a) is a block diagram and (b) is one example of the high-frequency component cut-off filter 910 of (a).
According to the embodiment of the invention 9, in (a), it is the feature to have formed the high-frequency component cut-off filter 910 which removes the high frequency component of the output (waveform error) which came out from the waveform error detection circuit 92 to the outside in gain variable amplifier by the amplifier input side of the gain variable amplifier circuit 91. This high frequency component cut-off filter 910 comprises a pi type filter which sandwiches the capacitors 912 and 913 from both sides right in the middle in the resistance 911 like a graphic display as one example.
By doing in this way, the high frequency component of the waveform error signal from the waveform error detection circuit 92 is removed, the noise of a waveform error signal ceases to carry out an adverse effect to a gain variable, and a reference current waveform is stabilized to a waveform error. It becomes strong also to disturbance.
[0036]
(Embodiment of the invention 10)
He is trying for the embodiment of the invention 10 to establish the reference signal conversion method which brings a reference waveform signal close to zero at the time of the phase which becomes low [commercial source voltage].
Drawing 9 is a figure explaining the reference signal conversion circuit used by this embodiment, as for a block diagram and (b), one example of the reference signal

conversion circuit of (a) and (c) of (a) are wave form charts, (1) is a reference waveform and (2) is a waveform error signal.
In drawing 9 (a), as for the phase (near 0 times, near 180 degrees) which this reference signal conversion circuit 620 is inserted between the plastic surgery filter 62 and the gain variable amplifier 91, and becomes low [commercial source voltage], 620 carries out ****** which brings a reference waveform signal close to zero by a reference signal conversion circuit.
[0037]
In (b), the reference signal conversion circuit 620, Transistor Tr62 is connected with a Vcc power source between the input terminals of the gain variable amplifier 91, The direct current voltage 62 is inserted between the base of transistor Tr62, and a ground, and the resistance R62 is inserted upstream of the node of the emitter of transistor Tr62, and the input terminal of the gain variable amplifier 91, and it changes.
If the full wave rectification Vs of exchange arrives at the input terminal of the gain variable amplifier 91 now, when the voltage of Vs is larger than the specified value V2, transistor Tr62 will be OFF, and full wave rectification as it is will be obtained.
However, since transistor Tr62 becomes one and Vcc voltage is impressed to the input terminal side when the voltage of Vs becomes smaller than the specified value V2, the waveform not more than V2 turns into a waveform which stops having appeared and was raised by predetermined low voltage. And if this wave-like level is shifted and a low voltage portion is doubled with 0, desired waveform Vs' will be obtained.
[0038]
(1) of a figure (c) is an enlarged drawing of this waveform Vs', and the phase (near 0 times, near 180 degrees) which becomes low [commercial source voltage] is approaching zero in the reference waveform signal. A control action is stabilized by using such a waveform. Because, since current cannot be sent through a magnetron from the first, it is not necessary to take out a waveform error signal with the place of the phase (near 0 times, near 180 degrees) which becomes low [commercial source voltage] to unreasonableness. Therefore, it is because the operation of the phase which becomes low [commercial source voltage] which will control unstably by taking out a waveform error signal if the reference waveform signal is made into zero by the way is lost. Operation became unstable easily and Drawing c (2) had also produced the amplitude value C1 of the error signal greatly in the place of the phase (near 0 times, near 180 degrees) which is a waveform error signal by a conventional method, and becomes low [commercial source voltage] as shown in a figure. Since according to this embodiment it will be cut as this portion of C1 shows by hatching, operation will be stabilized.
[0039]
(Embodiment of the invention 11)
The embodiment of the invention 11 forms the band pass filter 621 in the above-mentioned shaping circuit 62 as an example of a filter which attenuates the harmonics ingredient of commercial power frequency, and constitutes a plastic surgery filter circuit.
Drawing 10 is a figure explaining the embodiment of the invention 11, (a) is a circuit diagram and (b) is a gain frequency characteristic figure.
621 is the band pass filter provided in the shaping circuit 62 by the embodiment of the invention 11, and he is trying to attenuate the several ingredients high order which exceeds commercial power frequency with this band pass filter 621 in a figure (a).
The gain frequency characteristic of the band pass filter 621 is shown, the harmonics ingredient of the high order number of commercial power frequency is cut, and, on the other hand, the magnitude of attenuation of the harmonics ingredient of a lower degree ingredient has (little b). Since a power-factor becomes good compared with a sinusoidal reference signal system with a conventional microcomputer and the distortion component and noise of a high order number are cut as it explained by Embodiment 2, since the distortion component of the lower degree of commercial power frequency remained with this, operation is stabilized and it becomes strong to disturbance.

[0040]
(Embodiment of the invention 12)
The embodiment of the invention 12 is advancing the phase of the reference waveform in the above-mentioned Embodiment 2 beforehand in consideration of the time delay of a control system. A power-factor improves by doing in this way. Drawing 11 is a figure explaining the embodiment of the invention 12, and (a) is a circuit diagram and a figure explaining the phase leading of the (b) reference waveform.
In a figure (a), 620 with an example of the filter circuit provided by the embodiment of the invention 12. The highpass filter which cuts a low-pass ingredient is roughly constituted from the resistance R61, and R62 and the capacitor C61, the low pass filter which omits a high-frequency component by the resistance R63, and R64 and the capacitor C62 is constituted, and it has the composition of giving DC bias by the resistance R61 and R62. In the above-mentioned filter, the cut off frequency of a low pass filter is higher than power supply frequency, and the cut off frequency of a highpass filter is setting up low, and becomes a band pass filter of the characteristic shown in the gain frequency characteristic of a figure (b).
The frequency of the signal inputted into a filter is shown on a horizontal axis by the phase-frequency characteristic of a figure (b), and the phase change of the output signal over it is shown on a vertical axis. Since the above mentioned low pass filter is a late phase circuit and a highpass filter is a phase leading circuit, as shown in a figure, on frequency higher than power supply frequency, a phase is overdue, and the phase is progressing on frequency lower than power supply frequency, but. By setting up said cut off frequency become high a little from power supply frequency about the frequency in which a phase crosses 0 times, as shown in a figure, he follows the phase of the reference signal in power supply frequency, and only quantity deltaphi is advanced. Therefore, since a control system follows the reference signal which advanced the phase to power supply voltage with some delay, an input current waveform phase agrees in power supply voltage, and the rate of high tensile is obtained.
[0041]
[Effect of the Invention]
As mentioned above, according to this invention, the input current of the inverter circuit which rectifies AC power voltage and is changed into exchange of predetermined frequency is detected, Rectify this detection current, and ask for an input current waveform and, on the other hand, said AC power voltage is rectified, By shaping in waveform, asking for a reference waveform, searching for the difference of said input current waveform and said reference waveform, mixing this difference information and a current control output in a mix circuit, and changing into the driving output of the switching transistor of said inverter circuit, Since the control loop operates so that an input current waveform may agree on the waveform standard which followed the waveform of input voltage, and the size of the input current, Even if the kind of magnetron and its characteristic have variation, the ebm (voltage between anode cathodes) change by the temperature of the anode of a magnetron or the load in a microwave oven and the input current waveform plastic surgery which does not receive those influences even if line voltage variation occurs further can be made.

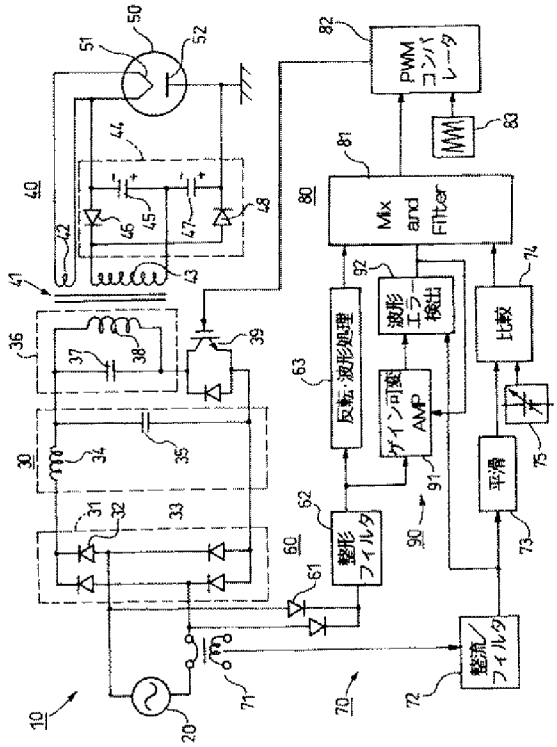
[Brief Description of the Drawings]
[Drawing 1]This invention is a block diagram of the target magnetron drive power supply.
[Drawing 2]It is a circuit diagram showing one example of the mix circuit 81 of drawing 1.
[Drawing 3]It is a figure explaining the waveform acquired by the embodiment of the invention 1, and when an input current is large, (b) of (a) is when an input current is small.
[Drawing 4]It is a circuit which shows the example of composition which omits the high-frequency component concerning the embodiment of the invention 4.
[Drawing 5]It is a figure explaining the embodiment of the invention 6, and, in a block diagram and (b), (a of a characteristic figure and (c)) is a wave form chart.

[Drawing 6]It is a figure explaining the technique of providing a difference in the current increase and rising characteristics concerning the embodiment of the invention 7, and, as for a block diagram and (b), the 1st characteristic figure and (c) of (a) are the 2nd characteristic figure.
[Drawing 7]It is a figure explaining the composition which adds Vc limiter function concerning the embodiment of the invention 8 to a current control output, and (a) is a block diagram and (b) is an example of a concrete circuit.
[Drawing 8]It is a figure explaining the embodiment of the invention 9, and (a) is a block diagram and (b) is one example of the high-frequency component cut-off filter 910 of (a).
[Drawing 9]It is a figure explaining the reference signal conversion circuit used by the embodiment of the invention 10, and, as for a block diagram and (b), one example of the reference signal conversion circuit of (a) and (c) of (a) are wave form charts. (1) is a reference waveform and (2) is a waveform error signal.
[Drawing 10]It is a figure explaining the embodiment of the invention 11, and (a) is a circuit diagram and (b) is a gain frequency characteristic figure.
[Drawing 11]It is a figure explaining the embodiment of the invention 12, and (a) is a circuit diagram and a figure explaining the phase leading of the (b) reference waveform.
[Drawing 12]It is a figure explaining the high frequency heating device which carries out the control system for which these people applied previously.
[Drawing 13]It is an anode cathode impressed-electromotive-force-anode current characteristic figure of a magnetron, and is a figure in which (a) shows the kind of magnetron, (b) shows electric supply matching, and (c) shows the temperature of a magnetron, respectively.
[Explanations of letters or numerals]
20 AC power supply
30 Smoothing circuit
31 Diode bridge type rectification circuit
32 Diode
34 Inductor
35 Capacitor
36 Resonant circuit
37 Capacitor
38 Primary winding
39 Switching transistor
41 Transformer
42 3rd winding
43 Secondary winding
45 Capacitor
46 Diode
47 Capacitor
48 Diode
50 Magnetron
51 Cathode
52 Anode
61 Diode
62 Shaping circuit
63 Reversal and a waveform processing circuit
71 Current detection means
72 Rectification circuit
73 Smoothing circuit
74 Comparison circuit
75 Output set part
81 Mix and filter circuit
82 PWM comparator
83 Saw wave generation circuit

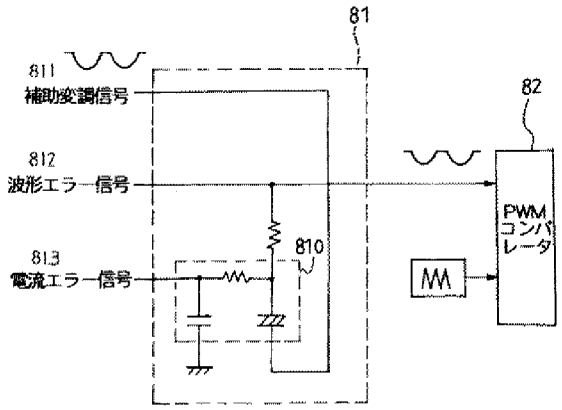
91 Gain variable amplifier circuit
92 Waveform error detection circuit
620 Reference signal conversion circuit
740 Comparator
741 An increase and a rising-characteristics difference processing capability circuit
810 High frequency cut-off filter
910 High-frequency component cut-off filter
921 Limit circuit

DRAWINGS

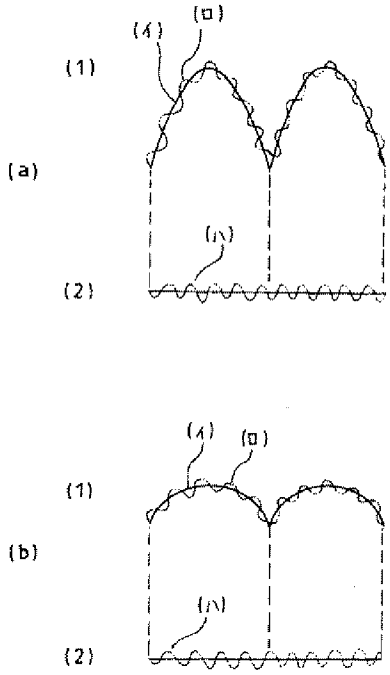
[Drawing 1]



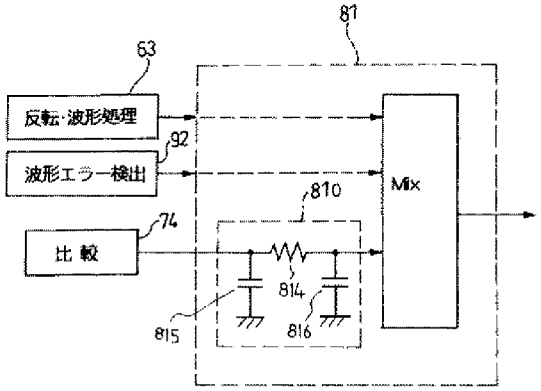
[Drawing 2]



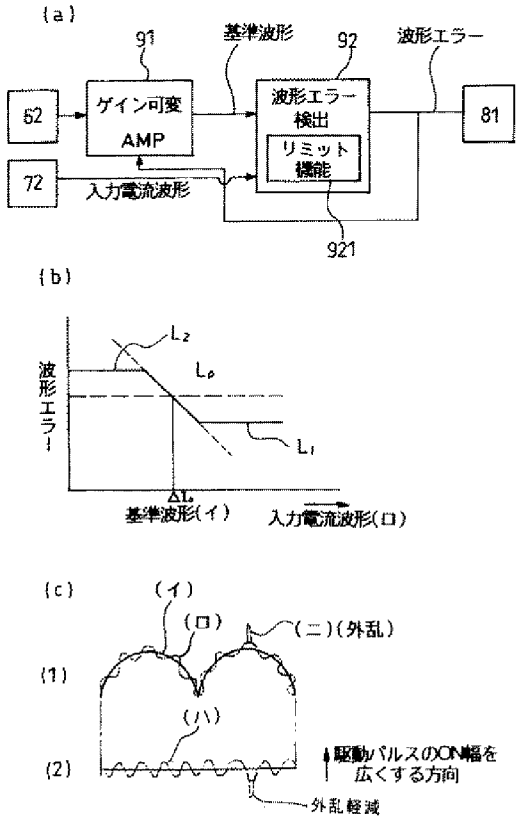
[Drawing 3]



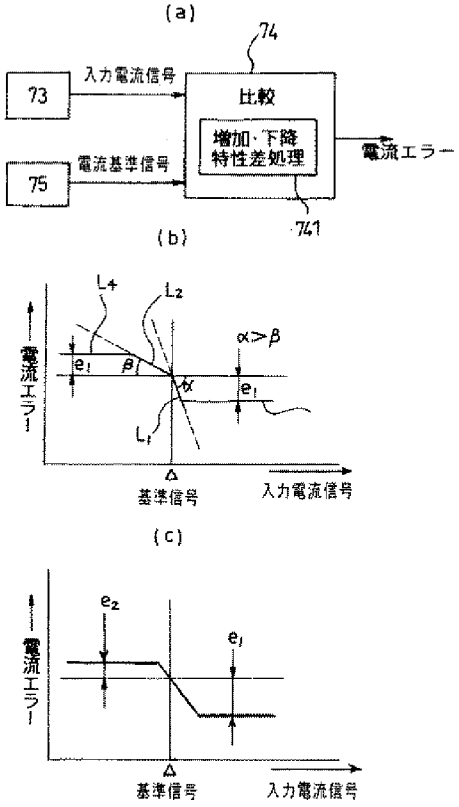
[Drawing 4]



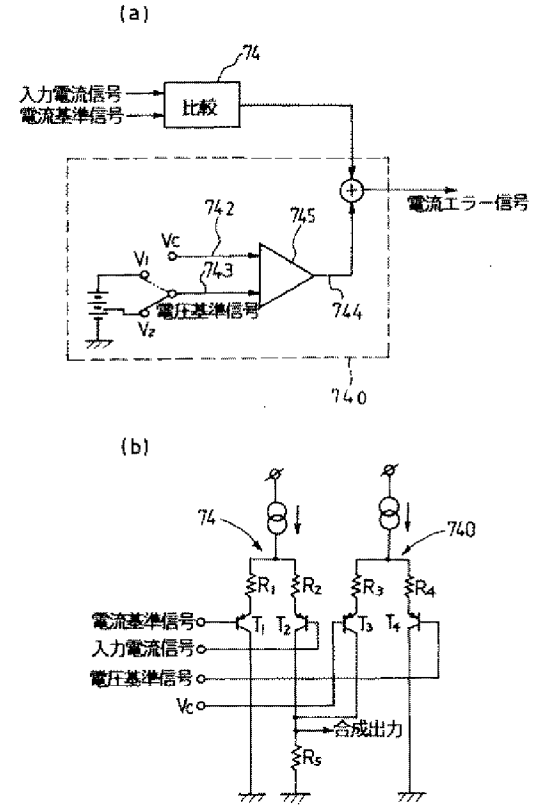
[Drawing 5]


(a)
91
基準波形
92
波形エラー
62
ゲイン可変
AMP
波形エラー
検出
リミット
機能
81
72
入力電流波形
921
(b)
波形エラー
L2
Lo
L1
ΔL
基準波形(イ)
入力電流波形(ロ)
(c)
(イ)
(ロ)
(ニ)(外乱)
(1)
(ハ)
(2)
駆動パルスのON幅を
広くする方向
外乱軽減

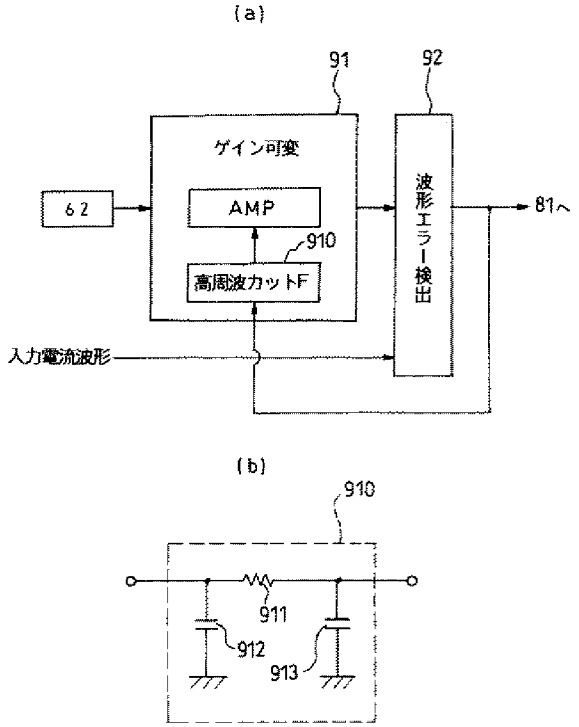
[Drawing 6]


(a)
74
73
入力電流信号
比較
増加・下降
特性差処理
電流エラー
75
電流基準信号
741
(b)
L4
L2
α>β
e1
β
α
e1
L1
電流エラー
Δ
基準信号
入力電流信号
(c)
e2
e1
電流エラー
Δ
基準信号
入力電流信号

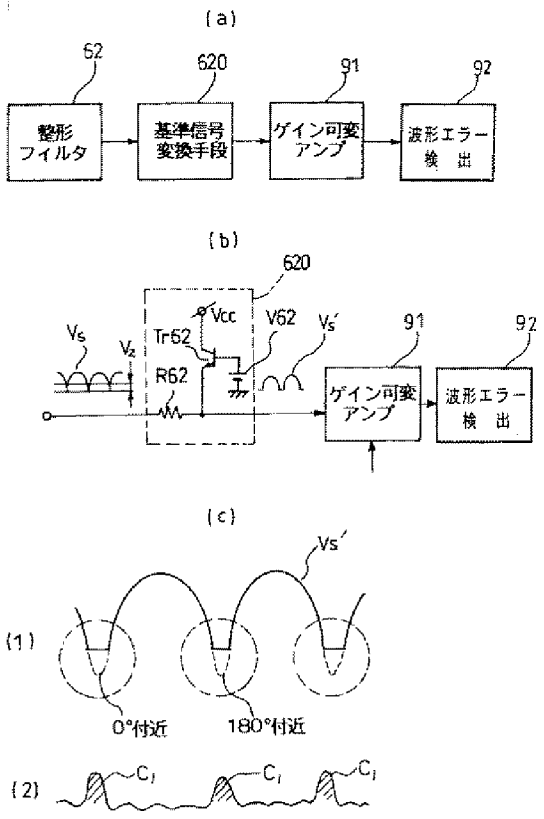
[Drawing 7]



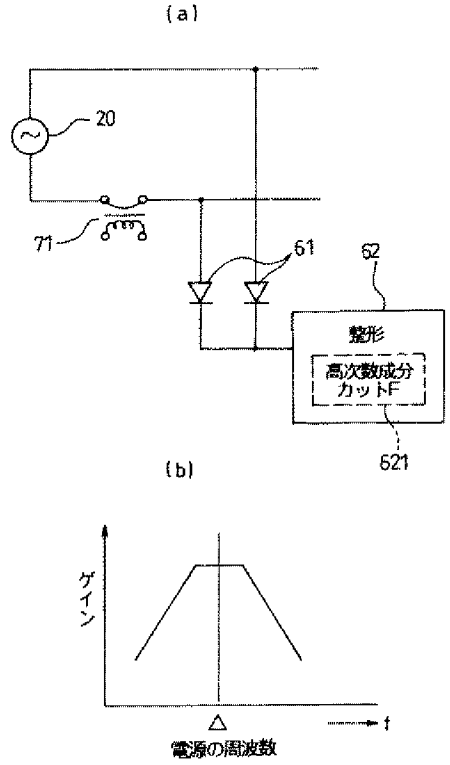
[Drawing 8]



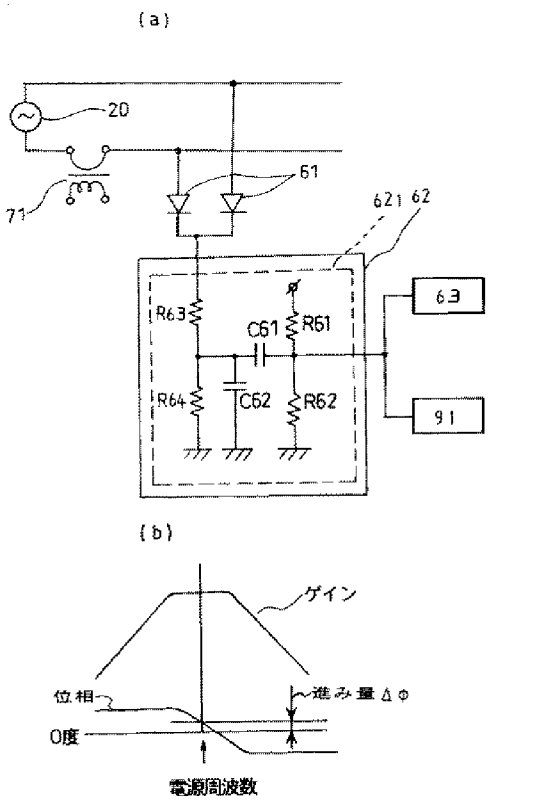
[Drawing 9]



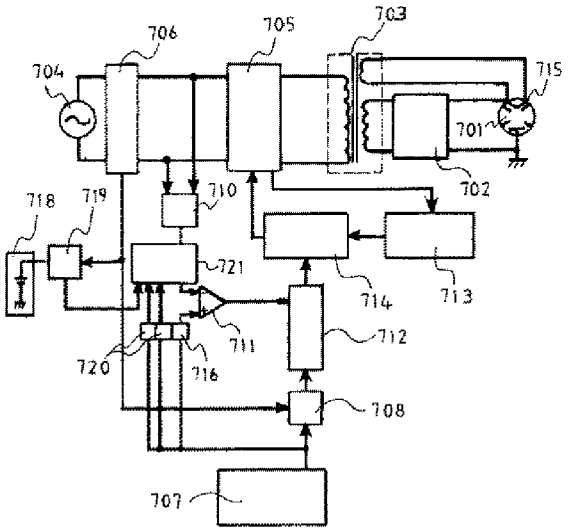
[Drawing 10]



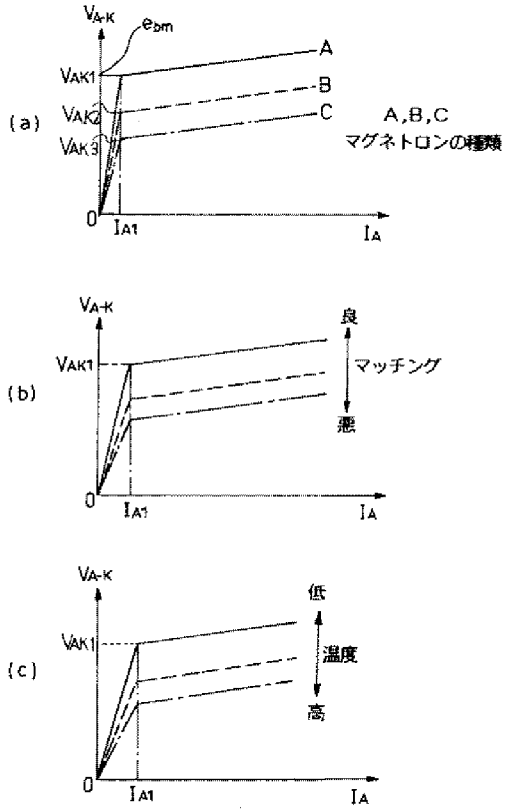
[Drawing 11]


(a)
20
71
61
621
62
R63
C61
R61
63
R64
C62
R62
91
(b)
ゲイン
位相
進み量 Δφ
0度
電源周波数

[Drawing 12]


706
705
703
704
715
701
702
718
719
710
721
714
713
711
712
720
716
708
707

[Drawing 13]


(a)
VA-K
ebm
VAK1
VAK2
VAK3
A
B
C
A,B,C
マグネトロンの種類
0
IA1
IA
(b)
良
マッチング
悪
(c)
低
温度
高